WBS 1.1.4 Installation Issues
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Introduction

In this document I discuss various WBS 1.1.4 installation issues, together with the coordination necessary with WBS 1.1.2 installation in the Target Hall and WBS 2.5 installation of the Minos Near Detector. Because of Davis-Bacon requirements, most of the WBS 1.1.4 installation work will be done by non-Fermilab personnel. It is envisaged that fixed price contracts will be the best means of getting the work done[1].

Table of Contents

[1] The advantages of fixed-price over time & materials are that the costs are known in advance and the workers obtained are presumed to be of a higher quality. The "disadvantage" is that the work must be carefully planned and described ahead of time. Also, as we learned from Wes Smart on 7/31, fixed price contracts involve creating a safety plan & satisfying other requirements that may inflate their cost (over using existing T&M contractors). This cost inflation effect is relevant for small-sized contracts.

Decay Pipe Ends

WBS 1.1.4 provides for the design, fabrication, and installation of the End Caps of the decay pipe. It also covers the connection of the downstream end cap to the piping to the vacuum pump, and the testing of the vacuum pipe for system integrity. The decay pipe, together with its shielding, is installed as part of the contract with S.A. Healy, Inc[2]; the cost[3] of this installation is part of WBS 1.2.

Interaction with WBS 1.1.2

The WBS 1.1.2 installation schedule has a period right after Beneficial Occupancy during which floor rails are placed and surveyed[4]. This is a period of duration 22 working days. After that, the schedule calls for installation of shielding at the downstream end of the target hall. The presence of the downstream shielding would effectively block all access to the upstream end of the decay pipe. Although the WBS 1.1.2 schedule could be altered to provide more time before the installation of the downstream shielding occurs[5], planning of the installation of the US and DS End Caps for the decay pipe (and vacuum tests of the decay pipe) should not assume such an alteration. It is the intent of this document to discuss an installation plan that installs both ends and does a system test during this 22 working day period. However, if the system test indicates a major problem with vacuum integrity, then there will be a delaying effect on the WBS 1.1.2 installation schedule. It is not the intent of this document to discuss at length the various types of major problems that might occur, and what would be the possible responses. If the only problem were small leaks at the weld joint at the upstream end of the decay pipe, it would

[2] Henceforth to be referred to with the abbreviation SAH. The abbreviation SAH indicates S.A. Healy, prime contractor for the NuMI tunnels. The abbreviation CB&I indicates Chicago, Bridge, and Iron, Inc—sub-contractors for the decay pipe steel and its installation.

[3] A recent addition to the scope of WBS 1.1.4 is funds to provide for a technician for 13 weeks, who will be present underground during all the welds of the decay pipe 40' sections. The technician will witness that CB& I is performing the weld tests on the joint welds that are specified in the contract with SAH.

[4] These floor rails provide the air channels necessary for the air cooling system intended for the target hall steel subject to beam heating.

[5] For example, according to Andy Stefanik, the WBS 1.1.2 schedule could be altered to have the green Duratek blocks in the bottom layer start installation before the downstream shielding—leaving the downstream area open for a longer period. Further schedule alteration could continue with shielding installation in the upstream area.

be possible to make a repair during the period when access was not blocked by the installation of downstream shielding in the target hall[6].

Upstream End

Installation of the upstream End Cap involves transporting it to the site, lowering it down the Target Hall shaft, and moving it into position at the upstream end of the decay pipe. It then must be braced in place and welded onto the SAH[7] provided end section[8]. If the welding is done by a contractor, the welders must be properly qualified. The 12 decay pipe cooling pipes that are installed by SAH must be cut close to the concrete shield and have elbows attached[9], so as not to get in the way of the welding operation for the End Cap.

Some of the reviewers at the 7/9/01 review of the decay pipe and its shielding recommended providing at the upstream end an instrumentation port. Also suggested was an upstream vent. The former suggestion is less controversial than the latter. Dave Pushka has suggested that the instrumentation port be connected to the vacuum guage by a long run of stainless steel tubing[10]; this would permit having elastomer seals well outside the zone where radiation damage is of concern.

Installation Equipment

Installation equipment for the upstream end cap is assumed to be a sub-set of the installation equipment that WBS 1.1.2 will find necessary. For the downstream end cap the installation equipment will the same equipment that will be necessary to install the absorber, its shielding, and the shielding upstream of the absorber (in the Absorber Cavern). The downstream installation equipment will have its first use with the installation of the end cap, and must be available right after Beneficial Occupancy. This equipment is planned as a Lazer forklift[11], together with a wheeled cart for long loads (such as the 7' long end cap). A special fixture is planned for the Lazer forklift—in order to move tall concrete shield blocks in a vertical orientation. Depending on the amount of

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6 Similarly, small leaks in the weld joint at the downstream end could be fixed during this period.

7 In actuality CB&I installs the decay pipe steel. SAH will install the concrete shielding around the decay pipe. Since SAH is the prime contractor, we'll only refer to them, in general.

8 The SAH provided end section will have 1' of steel pipe free of concrete shielding. At the 7/9/01 review there were suggestions that SAH provide internal bracing at each end section of the decay pipe--to ensure that the ends remained round (for a proper mating to the End Caps) during installation and the concrete shielding pour.

9 This is an interaction with WBS 1.1.7. Besides cutting the pipes and installing the elbows, it may make sense to route connecting lines as well prior to welding on the end cap. These connecting lines must follow a path consistent with the downstream shielding that will be placed in that area.

10 Bob Sanders commented on these instrumentation ports, in his list of comments from the 7/9/01 Decay Pipe Review.

11 Lazer forklift, from Hoist Liftruck. See URL for http://www.hoistlift.com/prodsdetail.asp?c=3.

concrete shielding installed (see later discussion), the Mini-Jack crane may or may not be necessary[12].

Welding equipment suitable for making the weld between end cap and decay pipe end section would also be included on the list of installation equipment that is necessary.

Downstream End

The downstream end cap is 7' in length. It's body diameter is 78". It incorporates a semi-ellipsoidal formed head at one end, an access port that extends[13] 70" to the beam east side, and a 10" diameter pump-out port angling upwards on the beam west side. It has a support carriage at the end near the formed head. The open end is intended for welding to the SAH provided end section. The connection of the pump-out port to the piping running to the vacuum pump ~100' away is discussed below.

Some of the reviewers at the 7/9/01 review of the decay pipe and its shielding recommended providing at the downstream end an instrumentation port. Also suggested was a drain port for removing water before the initial pump-down. Dave Pushka has suggested that the instrumentation port be connected to the vacuum guage by a long run of stainless steel tubing; this would permit having elastomer seals well outside the zone where radiation damage is of concern. A suggestion for the drain port was that it be welded shut after it is used to remove water[14].

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[12] Not having to install the Mini-Jack crane right after Beneficial Occupancy would be an argument for not installing the full height of the side shielding upstream of the absorber, on the beam west side—even at the cost of making a temporary vacuum connection to the downstream end cap. However, a careful study of how to install the base shielding just with the Lazer forklift would be necessary.

[13] Measured from the centerline of the decay pipe.

[14] I can't recall where the water comes from; neither can Dave Pushka (condensation, perhaps?). Since Jim Klein suggested this drain, we should probably ask him to refresh our memories.

Base Shielding

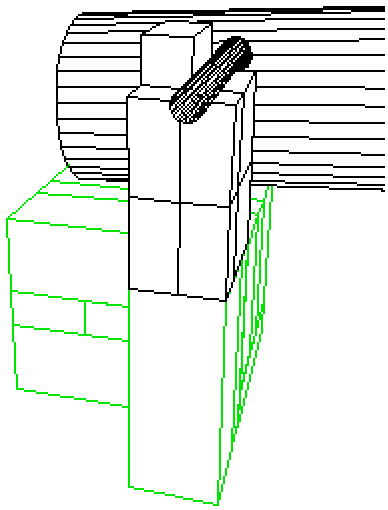

Figure 1, US end cap on shielding base, plus additional shielding

Here is a drawing of the US End Cap, its connecting piping, and the shielding beneath it and on the beam west side. The view is from the beam west side. The beam west shielding is present for proper routing the pipe to the vacuum pump.

Shielding between the upstream end of the Absorber Cavern and the start of the absorber can be considered as a logical extension of the shielding around the decay pipe. It will consist of concrete shielding blocks of various sizes, from the available Fermilab inventory. It is tailored to accommodate the access pipe, make space for the pump-out port piping to the vacuum pump, and make some provision for the presence of the downstream hadron monitoring equipment[15]. It also provides a support base for the undercarriage of the end cap. Enough shielding must be installed to provide this base—prior to installing the end cap (see Figure 1). We could install all the shielding in that area—below the level of the bottom of the end cap—or we could install a lesser amount that makes it convenient to do the welding of the end cap to the end section of the decay pipe. The connection of the vacuum pump to the end cap (in order to do a system integrity test) would have to be coordinated with the installation of the full height of the side shielding in this area on the beam west side, since the piping routes out through an opening in that shielding at the top[16]. Installation of the remainder of the shielding in this upstream area can be deferred until after the completion of the system integrity test for the vacuum pipe.

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[15] The purpose of the downstream Hadron monitoring equipment is to check proton beam alignment during beam commissioning. It will be positioned between the formed head of the end cap and the absorber core material. The plan for beam commissioning is to have a low intensity beam and no target, and measure the position of the beam with the downstream Hadron Monitor. Any plan to repeat this measurement after initial beam commissioning would have an added impact on the shielding design in the area just upstream of the absorber (since it may require a flexible means of access to the DS Hadron monitoring equipment).

[16] It might be better to provide a mock-up of that shielding, since we don't believe that the Lazer forklift mast goes high enough to install the second layer.

Vacuum Pump

In order to do a system integrity test a pump with sufficient capacity must be connected to the decay pipe. The logical choice of pump would be the one intended for continued use with the decay pipe, in position ~100' away, connected by the piping intended for that purpose. This pump would have to be installed in the initial period just after Beneficial Occupancy. The full complement of its controls would not be necessary, since the test would be closely monitored.

Integrity Test

The system integrity test would involve pumping down the decay pipe and ascertaining if there were leaks of any consequence[17]. Having vacuum instrumentation at both ends of the decay pipe (as well as at the vacuum pump itself) is something recommended by several of the reviewers from the 7/9/01 review of the decay pipe.

Leaks at the external ends of the decay pipe are presumably easily identifiable and repairable. Leaks internal to the decay pipe are not easily identified as such--especially their location. A detailed plan for finding and repairing an internal leak indicated during the system integrity test does not exist. If such a plan involves personnel access inside the decay pipe, ventilation requirements would either have a long air duct bringing air from downstream to upstream[18] or have an upstream air vent opening available.

Time Durations

US End Cap

Rigging of the US End Cap into position is assumed to take 2 hours, starting from the surface at the Target Hall shaft. Fixturing it and welding it into place is assumed to take four 8-hour shifts.

DS Shielding Base

Assuming the smallest possible base of shielding blocks (see Figure 1), we arrive at a count of 12 shielding blocks. This figure would increase to 24 if the all the blocks below

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[17] Phil Martin has suggested that the pump-down curve be predicted and compared with actual experience, in order to determine if there are leaks. I am not sure how this differs in effect from pumping down to some low pressure, closing a connecting valve, and observing the rate of rise of pressure.

[18] Assuming the downstream end cap is cut off and that there is no upstream air vent, an air duct that is potentially 675 meters long would be required—in order to ventilate the full length of the decay pipe. Such a duct would bring fresh air all the way from the open end. The fresh air would flow downstream towards the open end.

the level of the bottom of the DS End Cap were installed. In order to get sufficient height for installation of the 12 x 1.5 x 3 ft^3 J blocks that span across (above the DS End Cap) the base blocks sit on steel bricks.

In our cost estimates we projected 45 minutes, 6 riggers to get each piece of shielding into the Absorber Cavern, plus 1 hour, 3 riggers to position each piece[19]. We assume 6 hours of work per 8 hour shift. For the purposes of developing a time estimate, we can use the lower figure of 45 minutes per piece. This is 8 pieces per 8 hour shift.

The full base of 24 blocks would take three 8-hour shifts for the concrete blocks. Putting the steel bricks in place would take ~½ shift.

DS End Cap

Rigging the DS End Cap into place is assumed to take ½ of a 8-hour shift. Fixturing it and welding it into place is assumed to take four 8-hour shifts. Attaching it to the vacuum pump piping is assumed to take two 8-hour shifts.

Vacuum Pump

Rigging the vacuum pump skid into place would take ½ shift, at least. Making it operational is a time estimate that Dave Pushka should give. At the 7/9 review Dave gave a pump-down estimate of 24 hours for the decay pipe—assuming no leaks and a 400 cfm pump.

Hadron Absorber

Installation Equipment

The installation equipment for the Hadron Absorber includes the Lazer forklift already mentioned--as well as a wheeled cart that can be used with it for awkward-size loads. Also necessary is the Mini-Jack crane. For installation of the small concrete block shielding between the 7.5' tall labyrinth blocks and the access-way ceiling[20], specialized installation equipment such as a conveyor belt may prove useful.

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[19] These time estimates do not apply to the carrier plate, the water lines, or the secondary containment sheet metal. Each of these is not compact, like concrete shielding blocks or Duratek steel blocks, and it is assumed that handling non-compact shapes will be more complex. Also, these are one-of-a-kind items.

[20] The shape of this ceiling is shown on the drawings as a smooth arch. However, bedding planes in the rock in the ceiling may result in a much different shape. If the rock removal follows bedding planes, the result could be a higher ceiling. The smooth arch ranges from a height of 8' at the sides to 10' in the center. The use of sandbags as fill material has the liability that the bags may break or deteriorate. This has negative implications for the decommissioning phase that occurs after the facility no longer has a useful life. Small concrete blocks would be preferable.

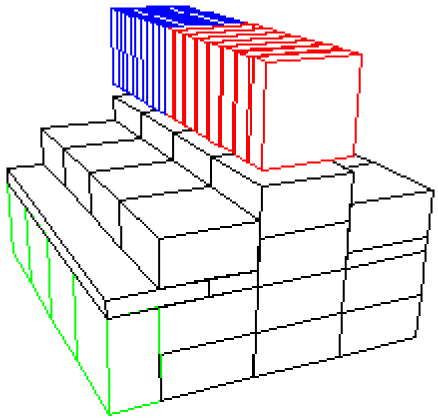

Figure 2, Core on base of shielding

This drawing shows the core and a base of Duratek blocks. The base configuration is chosen to facilitate welding of the water cooling pipes to the aluminum modules; a different configuration might even be better. The aluminum modules are colored red; the steel behind them is colored blue. The core carrier plate is not shown. The view is from upstream. Not illustrated is a layer of sheet metal for secondary containment.

Welding equipment suitable for making the weld between end cap and decay pipe end section might also be included on the list of installation equipment that is necessary.

Base Shielding

The base shielding of the absorber would be that amount of shielding that allows for assembly of the core. It includes Duratek blocks which don't directly support the core, but whose presence would make it easier to do the welding of the cooling water piping to the aluminum modules. It could also include any blocks planned for installation of the water manifold[21]. Blocks not part of the base would be installed after the core was assembled and tested. For example, blocks to either side of the core would get in the way if put in place prematurely. The support steel plates and top blocks would clearly go in place after core assembly and testing. Concrete shielding wrap would not be "base" shielding (except as already noted in the comment about anchoring the water manifold).

Core Assembly

The absorber core consists of the core carrier plate, eight aluminum modules that will be water cooled, and ten layers of CCS steel[22] oriented vertically. The aluminum modules

[21] In this case we'd have to carefully examine the benefits of having these blocks available for anchoring the manifold, while carefully examining the disadvantages of having them in the way of installing upstream blocks not considered to be part of the "base" shielding.

[22] CCS steel is so-called Continuous Cast Salvage steel. It is nominally 9.1" thick, comes in various thicknesses and is usually cut in length so as to constitute a 20 ton truckload. It is steel that results from either end of a continuous run of hot-rolled steel from the steel mills, where the composition isn't good enough for sale as quality steel.

are 1’ thick along the beam direction, and 51” x 51” in the transverse direction. Each has two internal water passages, for cooling. Each has four water cooling pipes that must be welded to it. Holes must be provided for water lines passing through to the next module upstream.

The CCS steel plates have to have holes provided for the water lines passing through to the aluminum modules upstream. The plates need to be joined together in a manner that provides stability, yet which is consistent with good practice for a later decommissioning phase.

Carrier Plate

The carrier plate has dimensions 6 x 51 x 210 inches[3]. Its weight is 9.1 tons. It will be supported on Hillman rollers[23]. The Hillman rollers will be modified to add cam followers that will guide transverse motion. Underneath the carrier plate will be a steel plate with a hardened surface. Its horizontal surface will support the rollers of the carrier plate. Its vertical surface will engage the cam followers on the Hillman rollers. The Hillman rollers will allow for pulling out the core during a decommissioning phase[24].

Getting the carrier plate from the Minos shaft to the Absorber Cavern will be one of the more challenging installation tasks. The combination of Lazer forklift and wheeled cart will be used for this purpose.

Thermocouple Installation

Monitoring of temperature is planned for each aluminum module. Thermocouples are planned for this purpose. The 6/12/01 review recommended redundant thermocouples for such monitoring. On one or more of the aluminum modules a nest of thermocouples can be used for monitoring beam position.

The plan for routing of the thermocouple wire is to add a couple of extra holes in the modules, using the same methodology that is used to provide the holes for the water lines passing through. The same would be true of the CCS steel. The thermocouples could be mounted to the modules during assembly, while there is still space to make the attachment. Their wires could be routed through these extra holes when all modules and CCS steel are in place. In the interim, care would be necessary so that neither the wires nor their ceramic insulation[25] can be damaged.

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[23] These Hillman rollers will have rollers made of stainless steel, in order to resist corrosion.
[24] To pull out the core during a decommissioning stage it will be necessary to construct a platform at the downstream end which has a surface which engages the Hillman rollers and their cam followers in a manner that the core can be extracted. Such a platform has not been designed. In addition to this platform, a number of other items will be necessary. For example, a good deal of shielding must be put in place.
[25] The ceramic insulation is only necessary where high radiation levels are expected. By the time the wires exit the absorber, ceramic insulation is probably not necessary.

Thermocouple Instrumentation

The readout for the thermocouples would be located outside of the labyrinth in the access-way to the Absorber Cavern. Details of this readout have not been worked out.

Core Water Pipe Welding

All modules and CCS steel would be put in place before running water lines through the clearance holes. Three inches of space between modules is planned, as well as three inches of transverse space between water lines. This should provide enough space for welding the water lines to the modules. A practice setup for this welding is planned—to gain experience. This setup will be utilized well in advance of actual installation[26].

There has been some discussion of who would do this welding, and the later testing that the welds are leak tight. If the work is done by contract welders, their qualifications would have to be specified and they would have to provide samples of their work for testing. The work could be done by lab welders, but that would have to be arranged so as not to have complications from Davis-Bacon requirements.

Water Manifold

The water lines exit the absorber core at the downstream end and must then be routed to a manifold. The manifold serves to interface the 16 water circuits in the core to one supply line and one return line to the RAW system[27]. It also transitions between the aluminum water lines internal to the core and the stainless steel supply and return water lines in the RAW system. Current plans call for having a valve for each water path, so as to be able to isolate water circuits and identify which circuit is leaking—should a leak be detected during operations. No flow restrictors are planned (i.e. no balancing is planned for the different water circuits, to account for the different beam power levels deposited in each module).

The location of the water manifold should be in an accessible area, where residual radiation is not a severe problem. This would allow for utilizing the individual circuit valves to identify which water circuit is leaking, and other service operations—without risk of excessive radiation dose to service personnel or necessitating the movement or removal of shielding. The actual location of the manifold to achieve these aims is still under discussion.

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[26] Hopefully, this setup will available during Fall, 2001.
[27] The RAW system will be on the other side of the labyrinth in the Absorber Cavern access-way.

Test of Water System Integrity

After the welding of the water pipes to the aluminum modules (and their connection to valves and the water manifold) a system test should be done to determine that there are no leaks. Whether or not this test is done after connection to the RAW system has not been discussed. It might be done before the system is connected to the RAW system[28]. As with the welding of the water lines to the modules, further discussion of who will do this test is necessary. If it is contract personnel—utilizing a fixed price contract—the test will have to be carefully spelled out in contract documents.

Remainder of Shielding

After the absorber core has been assembled and tested for water system integrity the remainder of the absorber shielding can be installed. This includes the Duratek blocks that go next to the core on the sides, the steel plates that support the top layer of Duratek blocks, and the top layer itself. Also included is the layer of concrete shielding blocks on the beam east and downstream sides, as well as a 26" thick layer of Duratek blocks on the beam west side[29].

Labyrinth

Most of the labyrinth cannot be installed in the access-way until all installation work in the Absorber Cavern is complete. This includes removal of the Mini-Jack crane system, since that is not going to be left in place. Gordon Koizumi's plan for the labyrinth does have some blocks inside the Absorber Cavern, but they are in a position where the crane will be of little assistance. The shielding he calls for above those blocks will have to be installed without the help of the crane. The Lazer forklift will be used to position the blocks in the labyrinth. The count of B and C blocks in the labyrinth is 31. Four small sized shield blocks can be used for the "upper" shielding on labyrinth leg #1 inside the Cavern. Four "triangular" shield blocks are shown in Gordon's layout. These would have to be spaces filled with small concrete blocks. Fill above the 7.5' level for the labyrinth legs in the access-way would also be small concrete blocks. Steel plate would be used to span labyrinth legs and provide support for additional small concrete blocks at the 7.5' level and above. The time estimate counted 8 steel plates, 7 pallets of small concrete blocks, and 35 shield blocks. It also included 100 man-hours of work to install the small concrete blocks. The time duration would be about 13 8-hour shifts.

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[28] In that event, there would remain the test of whether or not the connections to the RAW system were free of leaks.

[29] The current design of the bridge and hook carriers for the Mini-Jack crane does not provide a full range of motion along the bridge, from this 26" layer of Duratek blocks to the 36" thick layer of concrete on the beam east side. The 26" layer of Duratek blocks on the beam west side can be put in place with the hook carrier in a special fixed position on the bridge.

Time Durations

Mini-Jack crane installation

Rigging time for the Mini-Jacks themselves was estimated to take 80% of a 8-hour shift. Another 8-hour shift is assumed for assembly of the Mini-Jacks. Rigging time for the 10 sections of rail was estimated the same way block rigging is estimated. Rigging time for the bridge was assumed to be a full 8-hour shift. The total is four 8-hour shifts.

Remainder of US shielding

If the base of the US shielding is assumed to be 24 concrete blocks, the remainder has a count of 30 concrete shield blocks. Installation time for these blocks would be 3 ¾ 8-hour shifts. Installation time for the DS Hadron Monitor would add to this time. A practical access scheme to this monitoring station has not been developed.

Shielding « base » and core assembly & test

The number of pieces shown in the shielding "base" in Figure 2 is 47. Another 17 pieces are the 8 aluminum modules and the 9 CCS plates behind them. Not shown is the core carrier plate, the specialized plate that it sits on, nor the sheet metal forming a secondary containment system. In our cost estimates we projected 45 minutes, 6 riggers to get each piece into the Absorber Cavern, plus 1 hour, 3 riggers to position each piece[30]. We assume 6 hours of work per 8 hour shift. For the purposes of developing a time estimate, we can use the lower figure of 45 minutes per piece. This is 8 pieces per 8 hour shift. The number of shifts to install the shielding base, core modules, and core steel is 64/8 = 8. The core carrier plate rigging is assumed to be ½ shift. These figures do not include time for inserting and welding the cooling pipes, nor time for routing thermocouple wire. In his estimate of costs Ernie Villegas allowed 80 hours for "Assemble and Test" Core on core carrier. This figure does includes the rigging time inside the cavern for the aluminum modules and the CCS steel behind them. Transporting water lines into the Absorber Cavern was estimated at two hours; transporting the secondary containment sheet metal was estimated at three hours. Ernie allowed 16 hours for "setup" of the secondary containment sheet metal, plus 16 hours of welding. The total is 21 8-hour shifts.

Remainder of Absorber

[30] These time estimates do not apply to the carrier plate, the water lines, or the secondary containment sheet metal. Each of these is not compact, like concrete shielding blocks or Duratek steel blocks, and it is assumed that handling non-compact shapes will be more complex. Also, these are one-of-a-kind items.

Not counting the pieces shown in Figure 2, there are 76 additional pieces of shielding in the absorber, plus the eight plates that support the top blocks. Installation of the additional 76 pieces will take 9 ½ 8-hour shifts. The size of the support plates is 1 x 26 x 156 in^3; each weighs 1148 lbs. Installing them will take an additional 8-hour shift.

Interactions with Near Detector Installation

Crane Sharing

Most installation effort in the Absorber Cavern involves the use of the ~300' drop crane in the Minos shaft. That crane will also be used for the installation of the Minos Near Detector in the Minos Cavern. Besides the issue of scheduling crane usage, the other factor in scheduling is that the Minos Near Detector installation labor will not be Davis-Bacon[31]. Virtually all of the installation in the Absorber Cavern is subject to Davis-Bacon requirements. The two efforts must be kept well separated in time, in order to avoid misunderstandings and labor conflicts. Some interleaving may be possible, since once a certain number of Near Detector planes are installed, time can be spent instrumenting them and testing their detectors, electronics, and readout. During such periods, the shaft crane would be available for work in the Absorber Cavern[32]. The details of such interleaving have not been worked out[33]. This statement is true both for the period of the first month after Beneficial Occupancy (where there is a definite priority on getting the decay pipe system test done expeditiously) and for later installation work[34] on the Hadron Absorber.

Interactions with WBS 1.1.7

The interactions with WBS 1.1.7 are that the decay pipe cooling pipes at either end of the decay pipe must be cut and fit with elbows, in order to make room for welding the end caps in place. WBS 1.1.7 supplies the vacuum pump and piping from it into the Absorber Cavern. Both the pump and the piping would have to be in place and

[31] This is the working assumption, since the effort is regarded as installation of an experiment—historically not an activity subject to the rules of Davis-Bacon.

[32] The possibility of non-crane usage periods in the Near Detector installation schedule—without affecting the overall duration of the schedule—was mentioned by Cat James at a 7/12/01 WBS 1.1.4 meeting.

[33] If we plan to use fixed price contracts for installation work in the Absorber Cavern, the cleanest arrangement would be to install the DS decay pipe end cap right after Beneficial Occupancy, test the decay pipe under vacuum, and then wait until all the heavy rigging was done for the Near Detector (a period of 6 months).

[34] During the installation of the absorber there will be a period of light to no crane usage—while the water piping is being welded to the aluminum modules and subsequently tested. There may be a desire to install a base of shielding for the core installation prior to completion of the Near Detector heavy rigging (which takes about 6 months), so as to allow the rigging in of the absorber core, installation of the water pipes, their welding, testing, installation of the thermocouples, installation of the water manifold, and connection of the manifold to the RAW system piping. In this case, completion of the rigging for the remainder of the absorber would follow the period of heavy rigging of the Near Detector.

sufficiently operational to do the vacuum integrity test for the decay pipe and its end caps. WBS 1.1.7 supplies the RAW pumps, heat exchanger, piping to the Absorber Cavern, etc. for the absorber core cooling. A system test of the RAW system (connected to the absorber core) should be done prior to installing the side and top shielding of the absorber.